REMARKS

Claim 1

Claims 1, 8, 10, and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye et al., U.S. Patent No. 6,169,294 (hereinafter "Biing-Jye") in view of Hunt et al., U.S. Patent No. 5,362,977 (hereinafter "Hunt"), and further in view of Ishikawa et al, U.S. Patent 5,696,389 (hereinafter "Ishikawa"). Applicants respectfully traverse the rejection.

A. Biing-Jye does not teach "a continuous uniform conducting sheet adjacent to the semiconductor structure [that] makes ohmic contact to the structure."

1. Biing-Jye teaches that the reflector, not the ohmic contact, is adjacent to the semiconductor structure.

Claim 1 recites "a multi-layered contact external to the semiconductor structure, the multi-layered contact comprising: a metallic reflector layer; a continuous uniform conducting sheet adjacent to the semiconductor structure, wherein the continuous uniform conducting sheet comprises a metal and makes ohmic contact to the structure; and a conductive barrier layer interposing the reflector layer and the continuous uniform conducting sheet." Claim 1 requires that the continuous uniform conducting sheet that makes ohmic contact to the semiconductor structure be adjacent to the semiconductor structure.

In contrast, in Biing-Jye's device, the reflector layer interposes the semiconductor structure and the ohmic contact layer. See for example, Biing-Jye, column 3, lines 16-24:

> The light emitting diode is grown over the transparent sapphire substrate (Al_2O_3). When the light emitting diode is placed upside down over the silicon substrate, the light emitted from the light emitting layer can efficiently transmit through the transparent sapphire layer. In addition, the bottom of the p-type GaN layer has an entire area plated with an ohmic layer such as Ni/Au. Without worrying about the light transmission efficiency, this metallic layer can exceed 100 A thick for more even current distribution than the

PATENT LAW GROUP LLP
2635 N. FIRST ST.
SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

conventional thin Au--Ni layer. Besides a reflecting layer may be plated under the ohmic layer to reflect the light incident downward back toward the sapphire for radiation. (Emphasis added.)

The second underlined sentence in the above quote indicates that when a reflector is included in Biing-Jye's device, the reflector is located under the ohmic layer, i.e. between the ohmic layer and the top semiconductor layer. The meaning of "under" in the second underlined sentence is defined by the first underlined sentence, which states that the light emitting diode is grown "over" the substrate. Biing-Jye thus fails to teach a uniform conducting sheet that makes ohmic contact to and is adjacent to the semiconductor structure in combination with a reflector layer, since the above quoted language of Biing-Jye indicates that when a reflector layer is included in the device, the ohmic contact layer is spaced apart from the semiconductor structure by the reflector layer.

2. It would not be obvious to place Biing-Jye's ohmic contact adjacent to the semiconductor structure since it is not transparent.

It would not be obvious to position Biing-Jye's reflector layer over the ohmic layer, such that the ohmic layer is disposed between Biing-Jye's reflector and semiconductor structure, since the stated purpose of Biing-Jye's invention is to provide a thick ohmic layer for even current distribution. Such thick ohmic layers are typically absorbing of light. In fact, Biing-Jye teaches that this layer may be thick "without worrying about the light transmission efficiency." Accordingly, a person of skill in the art would appreciate that it would be pointless to dispose a thick ohmic layer between the semiconductor structure and the reflector, since light from the semiconductor structure would be absorbed by the ohmic layer and would never reach the reflector, rendering the reflector useless.

PATENT LAW GROUP LLP
2635 N. FIRST ST, SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

Hunt and Ishikawa are cited in reference to the reflectivity of the contact and the barrier layer of claim 1 and as such add nothing to the deficiencies of Biing-Jye. Accordingly, claim 1 is allowable over Biing-Jye, Hunt, and Ishikawa, since even in

combination, these references do not teach "a continuous uniform conducting sheet adjacent to the semiconductor structure [that] makes ohmic contact to the structure."

B. Ishikawa does not teach a barrier layer external to the semiconductor structure.

Claim 1 teaches that the each of the metallic reflector layer, the continuous uniform conducting sheet, and the conductive barrier layer must be external to the semiconductor structure of the device, thus they must be external to all of the semiconductor layers included in the device.

As Applicants noted in the after final amendment filed September 8, 2003, the Examiner's citation of Ishikawa clearly ignores this portion of claim 1. The Examiner cites Ishikawa as teaching "a conductive barrier (128) interposing a reflector layer (127) and a continuous uniform conducting sheet (129)." See office action, page 3. Actually, Ishikawa at column 9, line 49 refers to layer 128 as a "hetero-barrier reducing layer." Layer 128 is thus likely a semiconductor layer, not a layer external to the semiconductor heterostructure. In any case, Ishikawa does not specify whether or not layer 128 is a semiconductor layer. Thus, Ishikawa does not teach a barrier layer external to the semiconductor heterostructure, as recited in claim 1.

In response to the above arguments, the Examiner states in the Advisory Action mailed September 25, 2003 that "Ishikawa clearly shows in Fig. 7 the barrier layer (128) external to the semiconductor heterostructure (121) as recited in claim 1." Applicants fail to see the relevance of this statement. Ishikawa's structure 121 is a GaAs substrate. On top of substrate 121, an InAl/GaAs and InAlP/InGaAlP reflection layer 127 is formed, followed by n-type layer 122, active layer 123, and p-type layer 124. Each of layers 127, 122, 123, and 124 are clearly semiconductor layers, and thus part of the semiconductor structure of

PATENT LAW GROUP LLP
2635 N. FIRST ST.
SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

Ishikawa. Any other semiconductor layers formed on top of layer 124 are also part of the semiconductor structure of Ishikawa. As described above, Ishikawa is silent on whether hetero-barrier reducing layer 128 is a semiconductor layer. If hetero-barrier reducing layer 128 is a semiconductor layer, it is not external to the semiconductor structure as required by claim 1. Thus, since Ishikawa is silent as to the composition of layer 128, Ishikawa does not teach a barrier external to the semiconductor structure.

C. Ishikawa's layer 128 does not interpose a reflector and a conducting sheet

Claim 1 recites "a conductive barrier layer interposing the reflector layer and the continuous uniform conducting sheet." In contrast, Ishikawa's layer 128 is formed between semiconductor cladding layer 124 and ohmic layer 129. The Examiner has provided no citation in Ishikawa that layer 128 may be placed at any other position, and no motivation to change the placement of layer 128. Accordingly, claim 1 is allowable over Biing-Jye, Hunt, and Ishikawa, since even in combination, these references do not teach "a conductive barrier layer interposing the reflector layer and the continuous uniform conducting sheet."

D. Conclusion

Even in combination, Biing-Jye, Hunt, and Ishikawa fail to teach at least the following elements of claim 1: 1. "a continuous uniform conducting sheet adjacent to the semiconductor structure, wherein the continuous uniform conducting sheet comprises a metal and makes ohmic contact to the structure" and 2. "a conductive barrier layer interposing the reflector layer and the continuous uniform conducting sheet." Claim 1 is thus allowable over the combination of Biing-Jye, Hunt, and Ishikawa.

PATENT LAW GROUP LLP
2635 N. FIRST ST.
SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

Claims depending fr m claim 1

Claims 8, 10, and 19 depend from claim 1 and are therefore allowable for at least the same reason as claim 1. Regarding claim 8, Biing-Jye clearly shows in Fig. 2A that the p- and n-contacts ("p-ohmic" and "n-ohmic") are formed on the same face of the semiconductor heterostructure, not opposing faces, since both the p- and n-contacts "face" in the same direction.

Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye, Hunt, and Ishikawa as applied to claim 1, further in view of Sugiura et al., U.S. Patent 5,932,896 (hereinafter "Sugiura"). Claim 3 depends from claim 1. Sugiura adds nothing to the deficiencies of Biing-Jye, Hunt, and Ishikawa with respect to claim 1, thus claim 3 is allowable for at least the same reasons as claim 1.

Claim 5 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye, Hunt, and Ishikawa as applied to claim 1 and further in view of Nakagawa et al., U.S. Patent No. 6,190,937 (hereinafter "Nakagawa"). Claim 5 depends from claim 1. Nakagawa adds nothing to the deficiencies of Biing-Jye, Hunt, and Ishikawa with respect to claim 1 thus claim 5 is allowable for at least the same reasons as claim 1.

Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye, Hunt, and Ishikawa as applied to claim 1 and further in view of Liu et al., U.S. Patent No. 5,789,771 (hereinafter "Liu"). Claim 6 depends from claim 1. Liu adds nothing to the deficiencies of Biing-Jye, Hunt, and Ishikawa with respect to claim 1, thus claim 6 is allowable for at least the same reasons as claim 1.

In addition, as applicants argued in the after final amendment filed September 8, 2003, the Examiner cites Liu as teaching a particular thickness for a conductive sheet in a multi-layer contact <u>external to the semiconductor structure</u>. Actually, the passage quoted by the Examiner deals with the thickness of a semiconductor layer, not a part of a multi-layer contact that is external to the semiconductor structure. In response to this argument, the Examiner

PATENT LAW
GROUP LLP
2635 N. FIRST ST.
SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

states "claims 6 and 16 do not claim a thickness of the multi-layer contact but a thickness of the sheet that makes ohmic contact." The Examiner's argument ignores the plain language of claim 1, which recites that the entire multi-layered contact, including the continuous uniform conducting sheet, is external to the semiconductor structure.. Accordingly, claim 6 is allowable for this additional reason.

Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye, Hunt, and Ishikawa as applied to claim 1, and further in view of Schetzina, U.S. Patent No. 5,351,255. Claim 7 depends from claim 1. Schetzina adds nothing to the deficiencies of Biing-Jye, Hunt, and Ishikawa with respect to claim 1, thus claim 7 is allowable for at least the same reasons as claim 1.

Claim 9 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye, Hunt, and Ishikawa as applied to claims 1 and 8 and further in view of Haitz et al., U.S. Patent No. 5,917,202. Claim 9 depends from claim 1. Haitz et al. adds nothing to the deficiencies of Biing-Jye, Hunt, and Ishikawa with respect to claim 1, thus claim 9 is allowable for at least the same reasons as claim 1.

<u>Claim 11</u>

Claims 11, 14, and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye in view of Hunt and Sugiura.

Claim 11 recites "a continuous uniform conducting sheet adjacent to the semiconductor structure, wherein the continuous uniform conducting sheet comprises a metal and makes ohmic contact to the structure."

PATENT LAW GROUP LLP
2635 N. FIRST ST.
SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

As described above in the section A, in Biing-Jye's device, the reflector layer interposes the semiconductor structure and the ohmic contact layer. See for example, Biing-Jye, column 3, lines 16-24:

> The light emitting diode is grown over the transparent sapphire substrate (Al_2O_3). When the light emitting diode is placed upside down over the silicon substrate, the light emitted from the light emitting layer can efficiently transmit through the transparent sapphire layer. In addition, the bottom of the p-type GaN layer has an entire area plated with an ohmic layer such as Ni/Au. Without worrying about the light transmission efficiency, this metallic layer can exceed 100 A thick for more even current distribution than the conventional thin Au--Ni layer. Besides a reflecting layer may be plated under the ohmic layer to reflect the light incident downward back toward the sapphire for radiation. (Emphasis added.)

It would not be obvious to position Biing-Jye's reflector layer over the ohmic layer, such that the ohmic layer is disposed between Biing-Jye's reflector and semiconductor structure, since the point of Biing-Jye's invention is to provide a thick ohmic layer to provide for even current distribution. Biing-Jye teaches that this layer may be thick "without worrying about the light transmission efficiency." Accordingly, a person of skill in the art would appreciate that there is no point in disposing such a thick ohmic layer between the semiconductor structure and the reflector, since light from the semiconductor structure would be absorbed by the ohmic layer and would never reach the reflector, rendering the reflector useless.

Hunt and Suguira are cited in reference to other claim elements and as such add nothing to the deficiencies of Biing-Jye. Accordingly, claim 11 is allowable over Biing-Jye, Hunt, and Suguira, since even in combination, these references do not teach "a continuous uniform conducting sheet adjacent to the semiconductor structure [that] makes ohmic contact to the structure."

Claim 27

Prior to amendment, claim 11 recited that the multi-layer contact has a specific contact resistance less than $10^{-2}\ \Omega\text{-cm}^2$. This element from claim 11 is now present in new claim 23, which depends from claim 11.

PATENT LAW GROUP LLP
2635 N. FIRST ST, SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

The Examiner cites Sugiura as teaching the above element of claim 23, stating "it would have been obvious to . . . use the contact resistance which is less than 0.01 Ω-cm^2 of Sugiura et al. in the light-emitting device of Biing-Jye et al. and Hunt et al. in order to improve ohmic contact as taught by Sugiura." As Applicants argued in the after final amendment filed September 8, 2003, this statement is absurd because it ignores the physical realities of designing a contact. Given a contact of a particular reflectivity, a person cannot simply choose to "use" a particular contact resistance, because the contact resistance depends on the materials used and the structure of the contact. In response, the Examiner states in the Advisory Action "The arguments against claim 11 is [sic] not persuasive because Sugiura et al. discloses in column 5, lines 18 ~ 32 to achieve good and low resistance ohmic contact by controlling the oxygen and carbon concentration on the uppermost surface of a growing layer not the materials of the contact layer." The Examiner correctly notes that the cited passage of column 5 of Sugiura teaches controlling the resistance in a top semiconductor layer of a device. However, as is apparent to a person of skill in the art, the resistance of a contact depends on both the properties of the semiconductor on which the contact is formed and the properties of the metal layers forming the contact. If a metal that is a poor match to the underlying semiconductor layer is used on top of Sugiura's semiconductor layer as a contact, contrary to the Examiner's assertion, the contact would <u>not</u> have low resistance. Further, if metal contact layers over the first metal contact layer adjacent to the semiconductor are poorly chosen, the contact would not have low resistance. Accordingly, Sugiura's teaching of a *semiconductor* layer having a particular resistance does not teach a *contact to that semiconductor layer* having a particular resistance. Sugiura thus fails to teach a contact having the resistance specified in claim 22.

PATENT LAW GROUP LLP
2635 N. FIRST ST. SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

<u>Other claims depending from claim 11</u>

Claim 15 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye, Hunt, and Sugiura as applied to claim 11 and further in view of Nakagawa et al. Claim 15 depends from claim 11. Nakagawa adds nothing to the deficiencies of Biing-Jye, Hunt, and Sugiura with respect to claim 11 thus claim 15 is allowable for at least the same reasons as claim 11.

Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye, Hunt, and Sugiura as applied to claim 11 and further in view of Liu. Claim 16 depends from claim 11. Liu adds nothing to the deficiencies of Biing-Jye, Hunt, and Sugiura with respect to claim 11, thus claim 16 is allowable for at least the same reasons as claim 11. In addition, the Examiner cites Liu as teaching a particular thickness for a conductive sheet in a multi-layer contact <u>external to the semiconductor structure</u>. Actually, the passage quoted by the Examiner deals with the thickness of a semiconductor layer, not a part of a multi-layer contact that is external to the semiconductor structure. In response to this argument, the Examiner states "claims 6 and 16 do not claim a thickness of the multi-layer contact but a thickness of the sheet that makes ohmic contact." The Examiner's argument ignores the plain language of claim 11, which recites that the entire multi-layered contact, including the continuous uniform conducting sheet, is <u>external</u> to the semiconductor structure. Accordingly, claim 16 is allowable for this additional reason.

Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Biing-Jye and Hunt as applied to claim 11 further in view of Okazaki, U.S. Patent No. 5,990,500. Claim 18 depends from claim 11. Okazaki adds nothing to the deficiencies of Biing-Jye, Hunt, and Sugiura with respect to claim 11, thus claim 18 is allowable for at least the same reasons as claim 11.

PATENT LAW GROUP LLP
2635 N. FIRST ST.
SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481

In view of the above arguments, Applicants respectfully request allowance of all pending claims. Should the Examiner have any questions, the Examiner is invited to call the undersigned at (408) 382-0480.

Certification of Facsimile Transmission

I hereby certify that this paper is being facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

R Leiterman 4/7/04
Signature Date

Respectfully submitted,

R Leiterman

Rachel V. Leiterman
Attorney for Applicant(s)
Reg. No. 46,868

PATENT LAW GROUP LLP
2635 N. FIRST ST.
SUITE 223
SAN JOSE, CA 95134
(408) 382-0480
FAX (408) 382-0481